EFFECTS OF MATERIAL SELECTION ON INJECTION MOULDING PARAMETERS USING MOLDFLOW SIMULATION SOFTWARE

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SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project and in my opinion, this project is adequate in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering with Manufacturing Engineering.

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STUDENT'S DECLARATION

I hereby declare that the work in this project is my own except for quotations and summaries which have been duly acknowledged. The project has not been accepted for any degree and is not concurrently submitted for award of other degree.

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Dedicated to my beloved parents

Mr. Ismail Bin Derasid

Mrs. Siti Fatimah Binti Yusuff

And

All my sisters and brothers

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ABSTRACT

This dissertation deals with the effects of material selection on injection moulding parameters using Moldflow simulation software. The objective of this dissertation is to define suitable material in producing plastic product (book tray) in term of Profit. The dissertation also describes the finite element analysis techniques to know the effect of cycle time to production cost and reduce the cost in define the material selection using manual method. Eight plastic materials were studied in this dissertation which commonly used in industrial. The three-dimensional solid modelling of plastic product (book tray) was developed using the computer-aided drawing software. The dimension of product based on the actual product mould. The three-dimensional solid modelling of plastic product will import to the computer aided engineering software. The computer aided engineering software was then performed is using Moldflow (MPI) simulation software. The computer aided engineering model of product was analyzed using injection flow analysis. The analysis need to repeat three time for each eight material. Finally, the average value of cooling time (s), filling time (s), and initial injection time (s) obtained from the analysis. From those parameters, the cycle time of product producing can be calculated for each eight material. The cycle time can relate to the production capacity, product cost and profit. From that comparison, the best material for plastic product (book tray) can be selected and also can know the effect of cycle time only on processing cost. By using this analysis method also can reduce the cost in define the material selection for plastic product using manual method.

ABSTRAK

Tesis ini menbentangkan kesan pemilihan bahan plastik ke atas parameter pembentukan acuan suntikan menggunakan perisian simulasi Moldflow. Objektif tesis ini ialah untuk mencari bahan plastik yang sesuai untuk barangan plastik (rak buku) dalam aspek keuntungan. Tesis ini juga menguraikan teknik analisis unsur terhingga untuk mengetahui kesan kitaran masa kepada kos pembuatan dan juga bagi mengurangkan kos untuk memilih bahan plastik untuk barangan plastik menggunakan mesin pembentukan acuan suntikan. Dalam pembelajaran ini, lapan bahan plastik yg biasa digunakan di industri dipilih. Permodelan struktur pejal tiga-dimensi bagi barangan plastik (rak buku) telah dibangunkan menggunakan perisian lukisan bantuan komputer. Ukuran saiz barangan plaktik itu berdasarkan ukuran yang terdapat pada acuan. Permodelan struktur pejal tiga-dimensi untuk barangan plastik itu dimasukan kedalam perisian kejuruteraan bantuan komputer. Perisian kejuruteraan bantuan komputer yang digunakan ialah perisian simulasi Moldflow (MPI). Permodelan kejuruteraan bantuan komputer menjalankan analisis suntikan aliran. Analisis Moldflow bagi setiap lapan bahan plastik itu hendaklah iulangi sebanyak tiga kali dan purata nilai masa menyejuk, masa mengisi dan masa permulaan suntikan di ambil. Kitaran masa dapat dikira berdasarkan tiga parameter yang diperolehi daripada analisis itu. Kitaran masa juga dapat di kaitkan dengan kepadatan pembuatan, kos barangan dan keuntungan. Bahan plastik yang terbaik untuk barangan plastik(rak buku) akan dipilih berdasarkan perbandingan antara lapan bahan plastik dari segi kepadatan pembuatan, kos barangan dan keuntungan. Daripada perbandingan itu juga dapat mengetahui kesan kitaran masa adalah kepada kos perlaksanaan sahaja. Dengan menggunakan analisis ini dapat mengurangkan kos untuk memilih bahan plastik untuk barangan plastik menggunakan mesin pembentukan acuan suntikan.

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LIST OF SYMBOLS

^{0}C	Degree Celsius
^{0} F	Degrees Fahrenheit
%	Percent
∑	Sum
€	Euro

LIST OF ABBREVIATIONS

3D	Three-dimensional
ABS	Acrylonitrile-butadiene-styrene
CAD	Computer aided drawing
CAE	Computer aided engineering
FYP	Final year project
HDPE	High density polyethylene
LDPE	Low density polyethylene
MPA	Moldflow plastics advisers
MPI	Moldflow plastics insight
PBT	Polybutylene terephthalate
PC	Polycarbonate
PE	Polyethylene
PEEK	Polyetheretherketone
PET	Polyethylene terephthalate
POM	Acatel
PP	Polypropylene
PS	Polystyrene
PVC	Polyvinyl chloride
SAN	Styrene acrylonitrile copolymer
SG	Specific gravity
UV	Ultraviolet

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

The injection moulding process is ideally suited to manufacture mass produced parts of complex shapes that require precise dimensions. One of the precise dimensions needs to consider is material selection. Depending on which data bank is consulted, there were between 17,000 and 18,000 different plastic materials available to choose. Because of the wide range of properties and cost associated with these materials, it is imperative that the material selection process be conducted with appropriate care and attention relative to finished product's appearance and function. The important item need to consider was the effect of material selection on processing.

Based on that case, the project title was proposed in studying the effects of material selection. The project is the effects of material selection on injection moulding parameters using Moldflow simulation software. This project involves the designing process and analysis process. Design process using computer aided design (CAD) software and analysis process using computer aided engineering (CAE) software. All the process method will combine to study and investigate the effect of material selection on injection moulding processing. The project purpose of this project is to define a good material selection on producing plastic product. At the end of the project, the material will be selected based on analysis of injection moulding parameter such as filling time, cooling time and cycle time.

1.2 PROBLEM STATEMENT

Injection moulding process is an expensive process especially in mass production. The material selection should be precise, accurate and effective because it of way to reduce the production cost. Below was common problem occurring while in material selection process:

(i) Low profit in production.
(ii) Higher cost in define the material selection by manual setting.

1.3 OBJECTIVE

The objective of this project is:

(i) To define suitable material in producing plastic product in term of Profit.
(ii) To know the effect of cycle time to production cost.
(iii) To reduce the cost in define the material selection using manual method

1.4 SCOPE OF WORK

The project will focus on the analysis the effect of material selection on injection moulding parameter using Moldflow simulation software. During analysis process, a few items should be scope as a guide the project flow. Below are a few project scopes for this project.

(i) The analysis process only run on one product because to prevent the error occur during the analysis process which is each plastic product have own characteristic.
(ii) The number of material that chooses limited to eight materials only. All of eight materials were selected based on product characteristic and suitable to injection moulding process.

(iii) The limitation of injection moulding parameter that considered is three parameters which are filling time, initial injection time and cooling time.

(iv) The limitation of analysis range is among injection moulding production in Malaysia only.

1.5 PROJECT PLAN

Please refer to appendix A for reference to this below description.

The project is begin with receive PSM title from supervisor and supervisor will explain briefly about that PSM title. Schedule management are needed for this project to make sure the project running in progress. Then, discuss with supervisor about the objective, problem statement, and scope of project. After discuss with supervisor, the project progress start with gather the information by research and literature review via internet, journal, reference books, supervisor and other relevant academic material that related to this project. To understand more about the project, need to study more about material related to the project topic and spend more than two week to make a literature review. Every week, improvement of knowledge is needed to make sure this project will be performing very well.

After few week, all the literature review that related to the project need to collect. The literature review must have material about injection moulding parameters, thermoplastic characteristic, types of plastic materials, cycle time, and Moldflow simulation software (MPI). The progress will continue with working on the design. In this project, need to redraw the plastic product using CAD software. Before draw, the dimension of that plastic product must be measure at that product mould. After drawing process was done, the project progress will continue with learn how to use the Moldflow software simulation. This step will take a few weeks to master that software. After that, task is preparation of progress presentation and report writing chapter one until chapter three. These tasks take two week to be finish. On that particular week, preparation needed to make a FYP one presentation.

The next task will be continuing on second semester with FYP two. The first task on second semester is discussed with supervisor about current progress and continuing the project progress. After that, project progress will be continuing with analysis the product CAD model using Moldflow simulation software. The simulation process begins with find the name of manufacturer for each eight plastic material. The names of manufacturer for each plastic material need to find because in Moldflow analysis need to define the name of manufacturer before run the analysis. The other parameters such as gate location, cooling system, injection pressure and runner are following the design of actual mould. The analysis should be repeated by change the type of material. This process will take a few weeks to done it. Then, the project will continue with collect the data such as filling time, cooling time and others. The data will be analyze by calculate the cycle time for each plastic material and select the best plastic material to be as the material in producing Book Tray product.

Lastly, the final report writing and prepare the presentation. This takes about one week to arrange and accomplish. A report is guided by FKM thesis format and also guidance from supervisor. All task scheduled is take around two semesters to complete.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Injection moulding is a process of forming a product by forcing molten plastic material under pressure into a mould where it is cooled, solidified and subsequently released by opening the two or three halves of the mould. Bryce.M.D (1996) has stated that the injection moulding is used for the formation of intricate plastic parts with excellent dimensional accuracy. A large number of items associated with our daily life are produced by way of injection moulding. Typical product categories include housewares, toys, automotive parts, furniture, rigid packaging items, appliances and medical disposable syringes.

Plastic injection moulding is one of the most important polymer processing operations in the plastic industry today. Ashby.M.F (2009) has stated that the plastic industry that is injection moulding and involving manufacturing has high growth potential caused by the products are made nowadays is from the polymer material. The most establish method for producing plastic or polymer parts in mass production is plastic injection moulding. This is a highly cost-effective, precise and competent manufacturing method, which can be automated. However, it is very costly tooling and machinery are needed this manufacturing process. The design of a polymer or plastic injection mould is an integral part of plastic injection moulding as the quantity of the final plastics part is greatly reliant on the injection mould. A plastic injection mould is a high precision tooling used to mass produce plastic parts and it by itself an assembly of cavities, mould base and standard components and more.

2.2 MOULD AND PRODUCT

2.2.1 Mould

Mould is one of important part in injection moulding process. Mould is consists of two types, two plate and three plate mould. This project needs to simulate the products that have produce by three plate mould. This mould produce plastic product known as 'Book Tray'. Below is characteristic of that mould.

(i) Three plate mould
(ii) Have six (6) gates, type of gate is pin point gate.
(iii) Have thirty (30) ejector pin.
(iv) Mould size is 500 mm x 500 mm x 440 mm
(v) Coolant system is horizontal type and the mould should be cooled by hot water controller (40 ^{o}C– 100 ^{o}C)
(vi) Cavity size is 249 cm^{3}

Figure 2.1: Three plate mould (book tray)

Source: FKM laboratory

2.2.2 Product

The product for this project is book tray. The product usually used at the office or education place. The function of this product is as storage for the papers, books, and paper work. This product need to design looked attractive because the product usually located on the table. Below is showing the picture of the product.

Figure 2.2: Book tray

Source: Solidwork (2006) 3D drawing

2.3 PROCESSING PARAMETER

Injection moulding process have a few processing parameter. The processing parameter such as:

(i) **Melt Temperatures**

Melt temperature is the temperature at which the plastic material is maintained throughout the flow path. Bryce.M.D (1996) has proposed that the temperature of the melt must be control along the path, starting with the heating cylinder. Below is suggested melt temperature for various plastic should be setting while injection moulding process.

Table 2.1: Suggested melt temperature for various plastics

Plastic material	**Temperature (^{o} C)**
Acrylonitrile Butadiene Styrene (ABS)	216
Polycarbonate (PC)	288
Polyethylene (PE)	210
Polypropylene (PP)	177
Polystyrene (PS)	199
Polyethylene terephthalate (PET)	280
Acetal (POM,Polyacetal)	218
Polybutylene terephthalate (PBT)	230
Acrylic	218
Cellulose acetate	196
Cellulose acetate propionate	177
Ethylene vinyl acetate	177
Liquid crystal polymer	260
Nylon	260
Polyallomer	252
Polyamide-imide	343
Polyarylate	371
Polybutylene	246
Polyetheretherketone (PEEK)	382
PVC	163

Source: Bryce.M.D, 1996, pp 31-32